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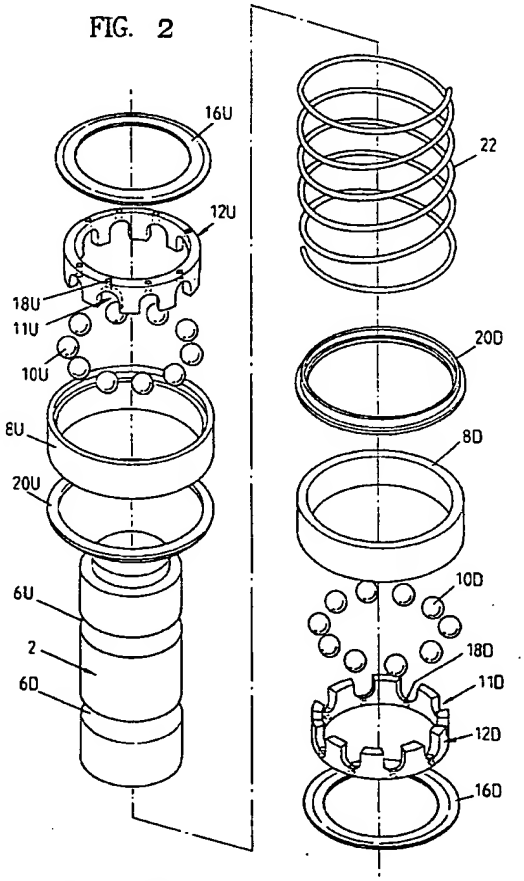
(54) Ball bearing assembly.

(57) A ball bearing assembly is provided in which the balls (IOU) are positioned between an inner race (6U) and an outer race (8U). The ball bearings are held in position by a ball cage (12U) which has U-shaped sections (11U) for accommodating the balls. A controlled amount of lubricant is fed to the balls through holes (18U) in the ball cage thereby avoiding the problem of surplus lubricant causing friction in the ball bearing assembly. The ball bearing assembly is suited for use in head positioning apparatus in a computer disk drive.

FIG. 2



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The present inv ntion relates to a ball bearing assembly having a ball cage or r tainer positioned between an inner race and an outer race for retaining balls within predetermined areas. The invention finds particular, but not exclusiv , application in head positioning apparatus in which a head carriage is mounted, through such a ball bearing assembly, on a base.

Viewed from one aspect the present invention provides a ball bearing assembly comprising: an inner race; an outer race; a plurality of balls positioned between said inner and outer races; and a ball cage for retaining said balls between said inner and outer races; characterised in that said cage has a lubricant receiving surface and lubricant feed passages leading from said receiving surface to said balls.

In order that the present invention will be fully understood preferred embodiments thereof will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG.1 is a cross-sectional view showing an embodiment of a ball bearing assembly in accordance with the present invention;

FIG.2 is an exploded view showing the components of the embodiment of FIG.1;

FIG.3 is a perspective view showing a crown-cap type retainer, shown in FIG.1 and FIG.2, having grease feeding holes, and a grease dispenser;

FIG.4 is a cross-sectional view showing an embodiment of a head positioning apparatus in which the bearing assembly shown in FIG.1 is used;

FIG.5 is a cross-sectional view showing another embodiment of a ball bearing assembly in accordance with the present invention;

FIG.6 is a plan view showing a head positioning apparatus of a conventional magnetic disk apparatus;

FIG.7 is a side view showing the conventional head positioning apparatus of FIG.6, a part of which is shown by a cross-sectional view;

FIG.8 is a cross-sectional view of a ball bearing assembly used in the conventional head positioning apparatus shown in FIG.6 and FIG.7;

FIG.9 is an exploded view showing the components of the bearing assembly used in the conventional head positioning apparatus shown in FIG.6 and FIG.7; and

FIG.10 is a partial perspective view showing an appearance of grease in the neighbourhood of a ball retainer of the bearing apparatus of the conventional head positioning apparatus shown inn FIG.6 and FIG.7.

FIG.6 and FIG.7 are a plan view and a side view, respectively, showing a head positioning apparatus of a conventional magnetic hard disk apparatus. A magn tic hard disk 102 is driven, through a spindl 104, by a spindle motor 106. A magnetic head 108 for writing data to the disk 102 and reading data from th disk 102 is mount d on on nd of a carriage 110. Th carriag 110 is fix d to a shaft 111, which is mounted, through a ball bearing assembly 114, on a housing base 116 so that th carriage 110 can pivot on a center axis 112 of the shaft 111. The carriage 110 is fixed to the shaft 111 by using a general method in which a bolt is screwed into a tapped hole formed in the shaft 111. Fixed to an end opposite, with respect to the axis 112 of the shaft 111, to the one end of the carriage 110 on which the head 108 is mounted, is a coil 118. Above the coil 118, a permanent magnet 120 is provided at a predetermined distance from the coil 118 and, on the other hand, below the coil 118, a permanent magnet 122 is provided at a predetermined distance from the coil 118. The coil 118 and the permanent magnets 120 and 122 compose a voice coil motor. The carriage 110 is pivoted on the axis 112 by a force generated by a current flowing through the coil 118 and a magnetic field produced from the permanent magnets 120 and 122. A direction in which the carriage 110 pivots is determined by the current that flows through the coil 118.

FIG.8 and FIG.9 are a cross-sectional view and an exploded perspective view, respectively, showing a ball bearing assembly used for the conventional head positioning apparatus of FIG.6 and FIG.7. As shown in these figures, a ball bearing assembly 114 comprises an upper bearing section 114U and a lower bearing section 114D. For the upper bearing section 114U a lubricant, such as grease 214U is applied to the top surface of a ball retainer 212U for retaining within a predetermined area, each of a plurality of balls 210U arranged between an inner race 206U formed integrally with the shaft 111 and an outer race 208U, and a shield ring 216U is provided on the top end of the outer race 208U to cover the grease 214U. For the lower bearing section 114D, grease 214D is applied to the bottom surface of a ball retainer 212D for retaining within a predetermined area, each of a plurality of balls 210D positioned between an inner race 206D formed integrally with the shaft 111 and an outer race 208D, and a shield ring 216D is provided on the bottom end of the outer race 208D to cover the grease 214D.

Also a ball bearing disclosed in Japanese Published Unexamined Patent Application (PUPA) No.1-316518 has a ball retainer with grease applied to its top surface.

In the conventional ball bearing shown in FIG.8 and FIG.9, since remaining grease 214U flows into a gap between the inner race and shaft 111 and the retainer 212U as shown in FIG.10, frictional force applied to the inner race and shaft 111 increases to prevent the shaft 111 from rotating smoothly. Also the grease 214D applied to the bottom surface of the retain r 212D of th lower bearing section 114D increases frictional force to th inner race and shaft 111.

Also in the case of th ball bearing disclosed in

Japanese PUPA No.1-316518, it is considered that r maining greas flows into a gap b twe n an inner rac and a bearing by which frictional force to the inner rac is increased, as described above.

In a head positioning apparatus of a computer disk drive in which a carriage for supporting a head is mounted, through a bearing, on a housing base, the increase of frictional force to a shaft or an inner race caused by the remaining grease, as described above, causes the accuracy of positioning to be reduced.

The ball bearing assembly of the present invention includes a ball cage or retainer for retaining within a predetermined area each of balls positioned between an inner race and an outer race, the retainer having lubricant, ie grease feeding holes which extend toward the balls.

The head positioning apparatus according to the present invention includes a ball retainer for retaining within a predetermined area each of balls positioned between an inner race and an outer race of a ball bearing, which is used for mounting a carriage for supporting a head on a base, the retainer having grease feeding holes which extend toward the balls.

In the ball bearing assembly and the head positioning apparatus according to the present invention, grease may be fed only to balls which actually need lubrication, without excess grease flowing into a gap between the inner race or the outer race and the ball retainer and preventing an increase in frictional force.

FIG.1 and FIG.2 are cross-sectional and exploded perspective views, respectively, showing an embodiment of a ball bearing assembly constructed in accordance with the present invention. A ball bearing assembly 1 shown in the figures comprises an upper bearing section 1U and a lower bearing section 1D provided below the upper bearing section 1U. The upper bearing section 1U comprises an inner race 6U formed integrally with a shaft 2 on which the bearing assembly 1 is mounted, an outer race 8U positioned coaxially and facing with the inner race 6U, a plurality of balls (ten balls in the embodiment) 10U provided between the inner race 6U and the outer race 8U, a ball retainer 12U which is formed from a hollow and cylindrical piece having a plurality of U-shaped slots or cuts (ten cuts in the embodiment) 11U at its bottom surface, each receiving one of the balls 10U, and a shield ring 16U fixed to the top end of the outer race 8U to cover the top surface of the retainer 12U. Since the balls 10U are accommodated in the respective U-shaped cuts 11U made in the retainer 12U, the circumferential movement of the shaft 2 is limited and two neighboring balls 10U retained within the predetermined areas are prevented from coming into contact with each other.

The lower bearing s ction 1D comprises an inn r race 6D formed integrally with the shaft 2 on which th bearing arrangement 1 is mounted, an ut r race 8D positioned coaxially and facing with th inner race 6D, a plurality of balls (ten balls in the mbodiment) 10D provided between the inner race 6D and the outer race 8D, a ball retainer 12D which is form d from a hollow and cylindrical piece having a plurality of U-shaped cuts (ten cuts in the mbodiment) 11D at its top surface, each receiving one of the balls 10D, and a shield ring 16D fixed to the bottom end of the outer race 8D to cover the bottom surface of the retainer 12D. Since the balls 10D are accommodated in the respective U-shaped cuts 11D made in the retainer 12D, the circumferential movement of the shaft 2 is limited and two neighbouring balls 10D retained within the predetermined areas are prevented from coming into contact with each other.

To prevent the upper bearing section 1U and the lower bearing section 1D from moving in the axial direction of the shaft 2, spring hold rings 20U and 20D are provided at the bottom surface of the outer race 8U and the top surface of the outer race 8D, respectively, and a pressuring spring 22 is provided between the rings 20U and 20D.

In the retainer 12U, grease feeding holes 18U which extend toward the balls 10U are made. The holes 18U are provided so that a hollow and cylindrical piece forming the retainer 12U is pierced thereby from the top surface to the U-shaped cuts 11U. In the retainer 12D, grease feeding holes 18D which extend toward the balls 10U are made. The holes 18D are provided so that a hollow and cylindrical piece forming the retainer 12D is pierced thereby from the bottom surface to the U-shaped cuts 11D.

FIG.1 shows a structure where the lubricant, eg grease 14U and 14D are already supplied to the grease feeding holes 18U and 18D. To supply the grease to the grease feeding holes 10U, as shown in, for example, FIG.3, a grease dispenser 30 may be used to emit the grease just like a syringe.

In the embodiment of FIG.1 and FIG.2, since the grease feeding holes 18U and 18D which extend toward the ball 10U and 10D, are made in the retainers 12U and 12D, respectively, grease is fed only to the balls 10U and 10D which actually need lubrication and no excessive grease flows into a gap between the inner race 6U, that is, the shaft 2 and the retainer 12U and a gap between the inner race 6D, that is, the shaft 2 and the retainer 12D so that high friction is not caused between the inner races 6U and 6D, that is, the shaft 2 and the bearing 1.

FIG.4 shows an embodiment of a head positioning apparatus, which uses the bearing arrangement 1 shown in FIG.1 and FIG.2, constructed in accordance with the present invention. In FIG.4, the same components as those shown in FIG.1 and FIG.2 are given the same reference numbers, which will not be explain d. Referring t FIG.4, th outer race 8D has a flange (not shown) formed at its bottom end and fix d to a housing bas 116, and th shaft 2 is fix d t a carriage 110 for supporting a h ad. Th carriag 110 is

driven, as in the prior art of FIG.6 and FIG.7, by a voice coil motor comprising a coil 118 and permanent magnets 120 and 122, to pivot on the axis of the shaft 2, and to be positioned to a disk 102.

In the head positioning apparatus of FIG.4, since the grease is fed only to the balls 10U and 10D which actually need lubrication, no excessive grease flows into the gap between the inner race 6U, that is, the shaft 2 and the retainer 12U and the gap between the inner race 6D, that is, the shaft 2 and the retainer 12D so that high friction can be avoided and the accuracy of positioning improved.

FIG.5 shows another embodiment of a ball bearing arrangement constructed in accordance with the present invention. According to the embodiment, an inner race comprises a component separate from a shaft. Referring to FIG.5, a ball bearing arrangement 31 comprises an upper bearing section 31U and a lower bearing section 31D, and an inner race 36U of the upper bearing section 31U and an inner race 36D of the lower bearing section 31D are fixed to a shaft 32. As the embodiment of FIG.1 and FIG.2, in the retainer 12U for retaining the balls 10U within the predetermined areas which are positioned between the inner race 36U and the outer race 8U, the grease feeding, holes 18U which extend toward the balls 10U are made and, on the other hand, in the retainer 12D for retaining the balls 10D within the predetermined areas which are positioned between the inner race 36D and the outer race 8D, the grease feeding holes 18D which extend toward the, balls 10D are made. Therefore, no remaining grease flows into a gap between the inner race 36U and the retainer 12U, a gap between the inner race 36D and the retainer 12D, a gap between the outer race 8U and the retainer 12U, and a gap between the outer race 8D and the retainer 12D so that high friction can be avoided.

Comparing the embodiment of FIG.1 with that of FIG.5, the embodiment of FIG.1 has the inner races formed integrally with the shaft and is, thereby, advantageous in that a lesser number of parts are required.

The embodiments described above relate to the ball bearing arrangement in which the inner races rotate and the outer races are fixed. However, it will be appreciated that the present invention can be applied not only to the above bearing arrangement, but also to an arrangement in which inner races are fixed and outer races rotate. Also in such a bearing, no remaining grease flows into a gap between a retainer and an outer race and a gap between the retainer and an inner race so that frictional force to the outer race may not be increased.

By using the above bearing arrangement in which the inner races are fixed and the outer races rotate, a head positioning apparatus of a magnetic disk apparatus can be constructed. In this case, a shaft, inner races, and outer races are fixed to the housing of the disk apparatus, the shaft, and a carriage, respectively.

Claims

1. A ball bearing assembly comprising:
   an inner race;
   an outer race;
   a plurality of balls positioned between said inner and outer races; and
   a ball cage for retaining said balls between said inner and outer races;
   characterised in that said cage has a lubricant receiving surface and lubricant feed passages leading from said receiving surface to said balls.

2. A ball bearing assembly as claimed in claim 1 wherein said ball cage is a hollow cylindrical piece having a plurality of U-shaped slots, each of said slots for receiving a respective ball.

3. A ball bearing assembly as claimed in claim 2 wherein said feed passages extend from said receiving surface to a respective apex of said U-shaped slots.

4. A ball bearing assembly as claimed in any of the preceding claims, wherein said inner race is formed integrally with a shaft on which said ball bearing assembly is to be mounted.

5. Head positioning apparatus for positioning a head relative to a disk in a computer storage system, said head being mounted on a support carriage and said support carriage being mounted to a base by means of a ball bearing assembly as claimed in any of the preceding claims.

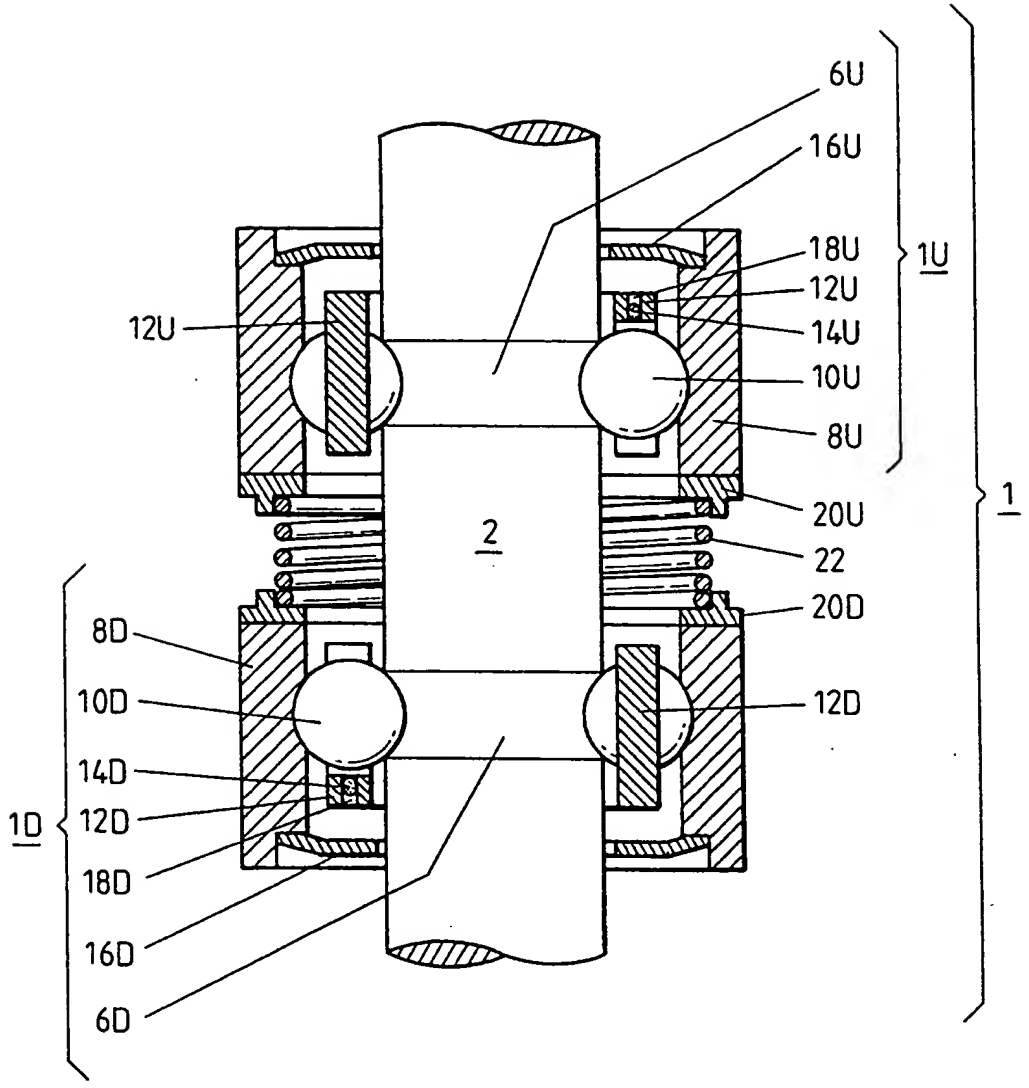
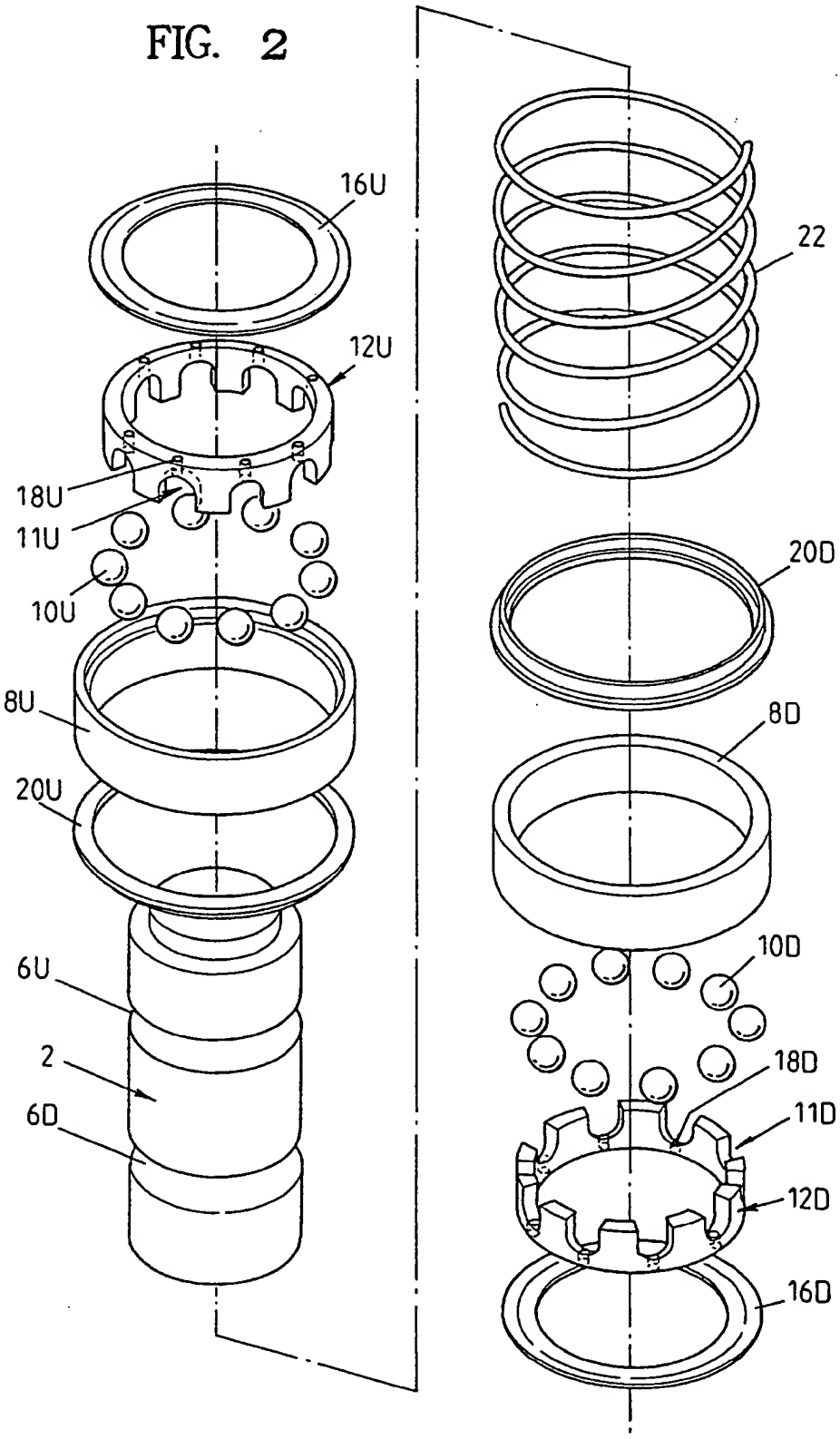

6U
16U
18U
12U
14U
10U
8U
1U
12U
1
2
20U
22
20D
8D
10D
12D
14D
12D
1D
18D
16D
6D

FIG. 1

FIG. 2



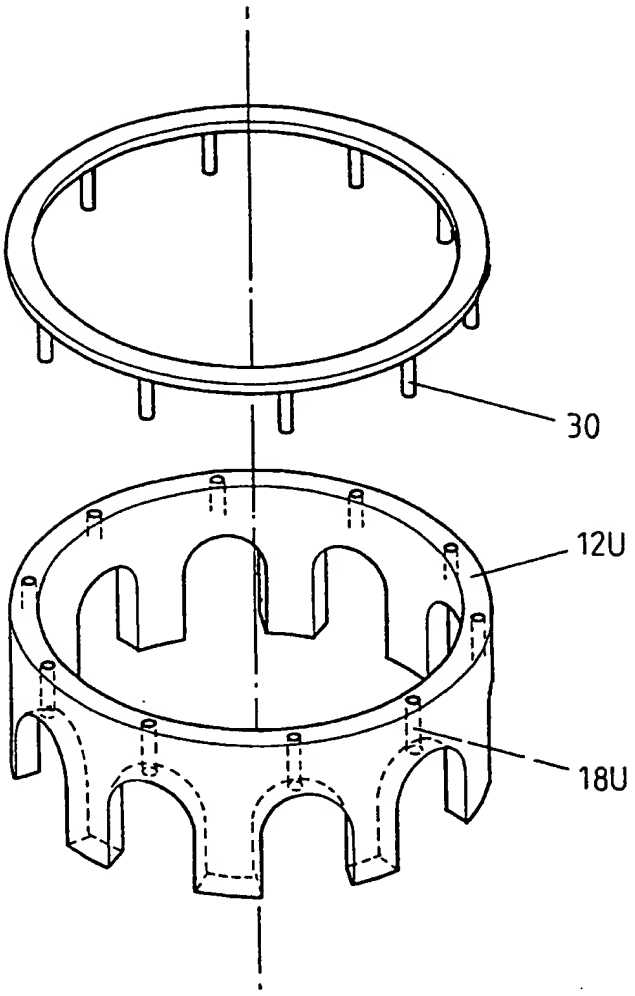


FIG. 3

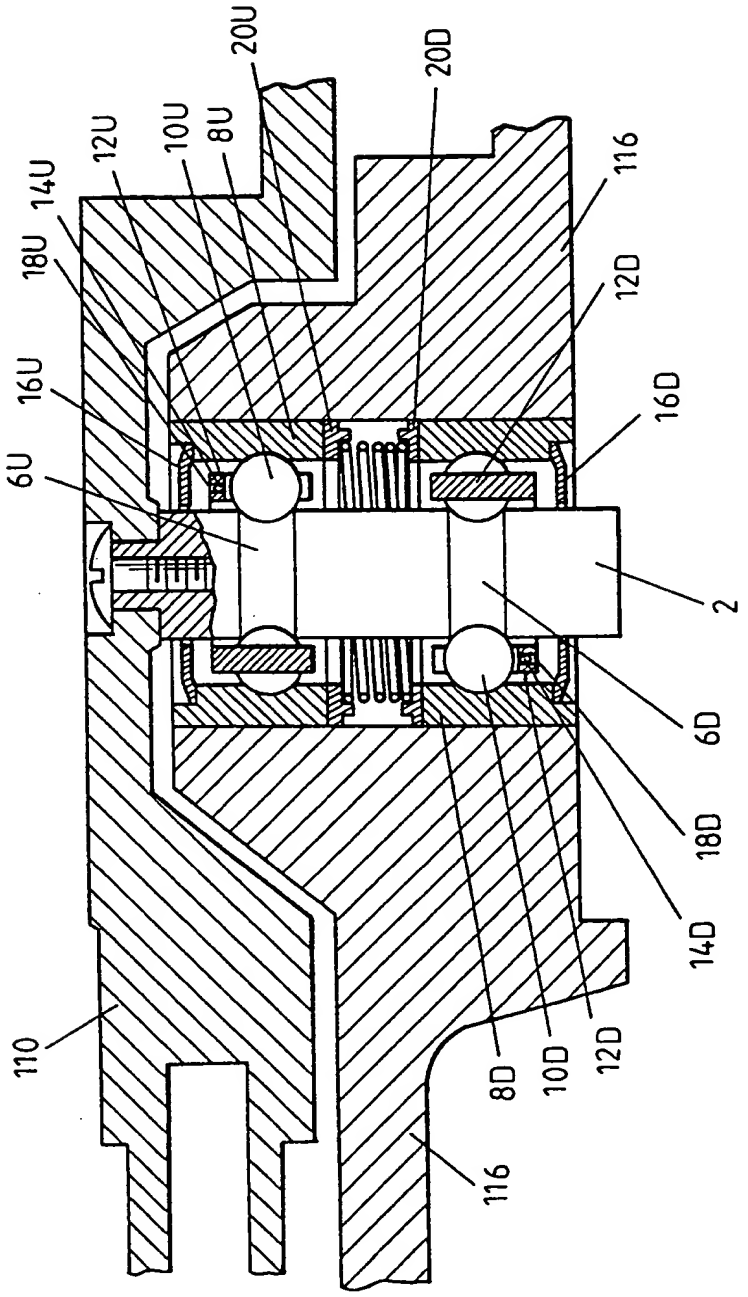
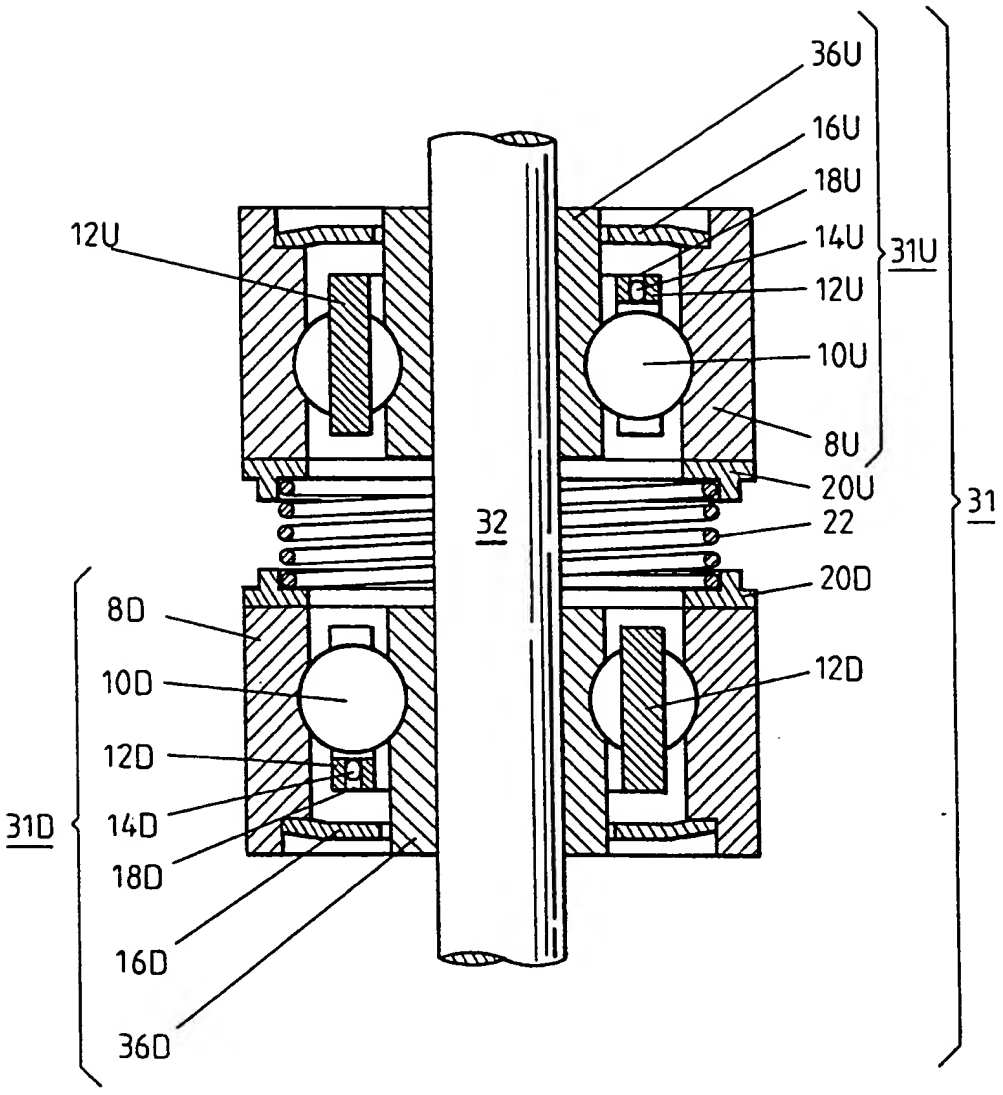

20U
20D
12U
10U
8U
14U
18U
116
12D
16U
16D
6U
2
6D
18D
14D
110
8D
10D
12D
116

FIG. 4


36U
16U
18U
12U
14U
31U
12U
10U
8U
20U
31
32
22
20D
8D
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12D
31D
14D
18D
16D
36D

FIG. 5

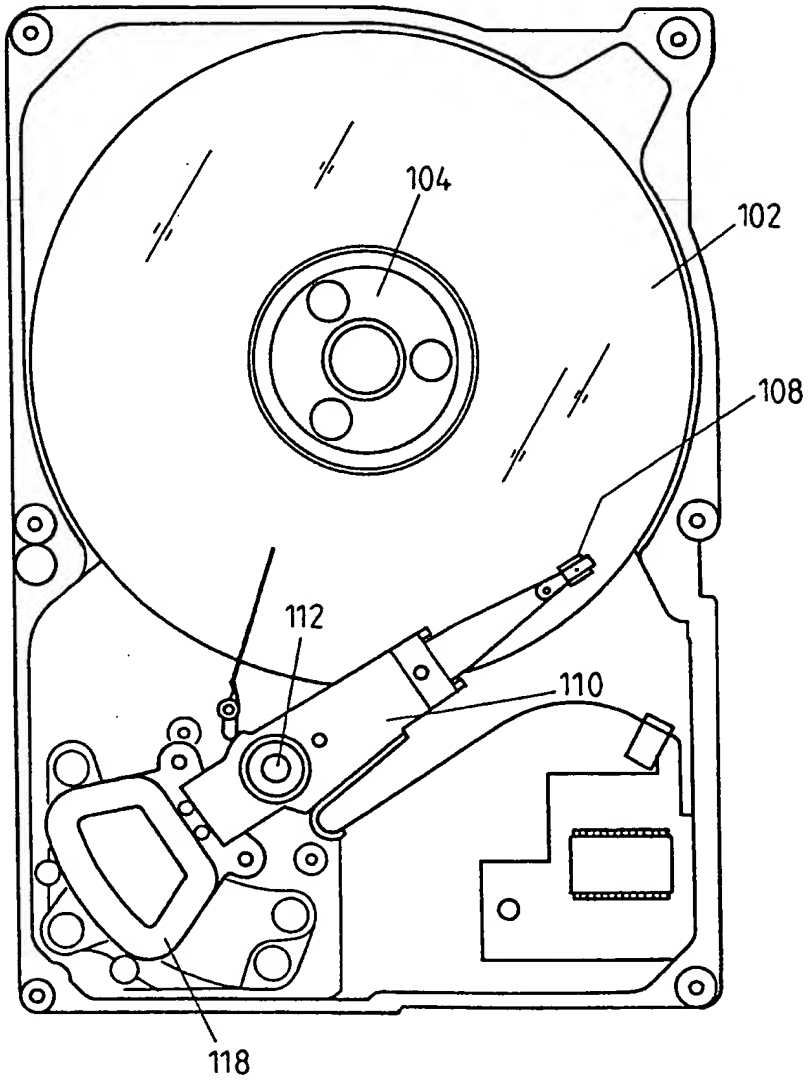

FIG. 6